the architecture of sustainable design

Sustainable Design Tools

sustainable design and
sustainable project rating tool
training course

SD Decision Support Tools

A sample of available tools for:

- Land Use Planning
- Green Buildings
- Energy
- Transportation
- Economics

Land Use Planning

- **SmartPlaces**
  - Electric Power Research Institute (EPRI)
  - SmartPlaces is a tool for geographic decision-making. SmartPlaces enhances decision-making insight in target marketing, economic development, land-use planning transportation systems, facilities management, environmental remediation and protection, energy forecasting, water allocation, and resource control.
  - SmartPlaces is used to evaluate the implications and opportunities of alternative plans. It offers innovation in the planning process through interactive design, evaluation, and illustration of proposed activities. The system runs on a PC using ESRI's ArcView software. Smart Places provides a user approachable set of tools for the exploration, design, modification, illustration and evaluation of alternative planning scenarios.
  - http://www.smartplaces.com

- **Social Cost of Alternative Land Development Scenarios (SCALDS)**
  - The Federal Highway Administration and Parsons Brinckerhoff, Quade and Douglas Inc.
  - A prototyping model that estimates the full cost of alternative land-use patterns. SCALDS estimates monetary and non-monetary costs associated with urban land development. It builds on three areas of research--least-cost planning, which has been used by utilities for a number of years; full cost of travel studies; and cost of service/cost of sprawl research.
  - http://www.ota.fhwa.dot.gov/scalds/

Land Use Planning

- **CITYgreen**
  - American Forests
  - A Geographic Information System (GIS) software program for mapping, measuring, and analyzing urban ecosystems. The program considers trees and other natural resources in the community development process. It allows users to create ecological maps, conduct technical analysis of the ecology, summarize results, and create graphic presentation materials. CITYgreen allows users to analyze storm water, summer energy savings, carbon storage and sequestration, air quality, and urban wildlife.
  - http://www.amfor.org
- **Community 2020**
  - U.S. Housing and Urban Development (HUD)
  - HUD's Community 2020 software Version 2.0 is a computer program packaged with geographic and demographic data.
  - With Community 2020, HUD not only has made its huge program data sets available to the public, but also has packaged the data with an easy-to-use, high quality GIS tool for understanding, using and communicating place-based information to others.
  - http://www.hud.gov

Green Buildings

- B E E S

  Building for Environmental and Economic Sustainability

  - BEES measures the environmental performance of building products
    - the environmental life-cycle assessment approach
  - BEES analyzes environmental impacts through all stages in the life of a product
    - raw material extraction
    - manufacture
    - transportation
    - installation, use
    - recycling
    - waste management
  - The BEES technique includes costs over a given study period of initial investment, replacement, operation, maintenance and repair, and disposal
  - Environmental and economic performance are combined into an overall performance measure (ASTM standard for Multi-Attribute Decision Analysis)
  - Building products are defined and classified according to the ASTM standard classification for building elements

Green Buildings

- LEED Rating System
  - US Green Building Council Rating System: Leadership in Energy and Environmental Design
  - The LEED Green Building Rating System TM is a priority program of the US Green Building Council. It is a voluntary, consensus-based, market-driven building rating system based on existing proven technology. It evaluates environmental performance from a “whole building” perspective over a building’s life cycle, providing a definitive standard for what constitutes a “green building”.
  - LEED is based on accepted energy and environmental principles and strikes a balance between known effective practices and emerging concepts. Unlike other rating systems currently in existence, the development of LEED Green Building Rating System TM was instigated by the US Green Council Membership, representing all segments of the building industry. and has been open to public scrutiny.
  - LEED is a self-certifying system designed for rating new and existing commercial, institutional, and high-rise residential buildings. It is a feature-oriented system where credits are earned for satisfying each criteria. Different levels of green building certification are awarded based on the total credits earned. The system is designed to be comprehensive in scope, yet simple in operation.

Green Buildings

- Green Building Advisor
  - Green Building Advisor (GBA) is an interactive software program that helps identify actions to reduce the environmental impacts of a building project, while ensuring healthy and productive indoor spaces. It is a revolutionary way of learning about green design and the cutting-edge techniques and technologies to accomplish it.
  - Green Building Advisor includes
    - green building design strategies
    - detailed green building case studies
    - green building product listings
    - bibliographic green building information references
    - full-text green building technical articles
    - Sustainable Building Manual

Green Buildings

- Green Building Challenge
  - A multi-year international assessment of green buildings culminating in an international conference
  - Involves the development of a framework designed to assess the energy and environmental performance of buildings.
  - The assessment framework builds on the experience from the first-generation systems.
  - The system is being developed with a core component reflecting global issues, but this will be complemented by overlays reflecting energy, environmental and other priorities in specific countries and regions. During1999 and 2000 the system is being used to prepare detailed performance assessments of the best green buildings from the participating countries.
  - http://www.greenbuilding.ca/gbc2k/gbc-start.htm

Green Buildings

- ATHENA
  - The Athena Sustainable Materials Institute, Canada
  - A major goal of the Institute is to develop building material life cycle inventory data for all key components of a building envelope.
  - Originally known as the Building Materials in the Context of Sustainable Development project.
  - A research alliance involving organizations and people with detailed knowledge about production processes for different building products, the use of those products in building and construction, and broader environmental issues associated with resource extraction and building demolition and disposal.
  - http://www.athenaSMI.ca/front/front.htm

Green Buildings

- **Building Life-Cycle Cost (BLCC)**
  - Computer program version 4.61 provides an economic analysis of proposed capital investments expected to reduce long-term operating costs of buildings or building systems. BLCC complies with American Society of Testing Materials (ASTM) standards related to building economics and NIST Handbook 135, Life-Cycle Costing Manual for the Federal Energy Management Program.
  - BLCC is the main program in a set of five NIST computer programs providing computational support for the analysis of capital investments in buildings.
  - http://www.eren.doe.gov/femp/resources.html
- **Green Developments CD-ROM**
  - U.S. DOE, Rocky Mountain Institute, and the Center for Renewable Energy and Sustainable Technology
  - Green Developments is an interactive CD-ROM that fully describes an exciting new field in which environmental considerations are viewed as opportunities to create better buildings and communities - by working with the environmental instead of against it.
  - It features of 400 visuals, resource details, including financial details, and live web links to key related sites. You hear the architects talking about their designs, see how the buildings have taken shape, and listen to residents talking about their neighborhoods while viewing them.

Green Buildings

- Green Spec
  - GreenSpec Binder
    - GreenSpec Product Directory
    - Guideline Specifications
      - manufacturer's product literature,
      - CSI division organization
      - guideline specification language
  - a comprehensive and up-to-date green product and specification guide
  - provides access to information on green building products and materials.
- BDA (Building Design Advisor)
  - DOE Lawrence Berkeley Laboratory
  - Software environment that supports the integration of multiple building models and databases
  - BDA acts as a data manager and process controller, allowing building designers to benefit from the capabilities of multiple analysis and visualization tools throughout the building design process. BDA is implemented as a Windows-based application. The 1.0 version has links to a Schematic Graphic Editor and two simplified simulation tools, one for daylight and one for energy analyses.
  - http://kmp.lbl.gov/BDA

Energy Simulation Software

- **BLAST** (Building Loads Analysis and System Thermodynamics)
  - Construction Engineering Research Laboratory and the University of Illinois
  - Performs hourly simulations of buildings, air handling systems, and central plant equipment in order to provide mechanical, energy and architectural engineers with accurate estimates of a building's energy needs. The zone models of BLAST, which are based on the fundamental heat balance method, are the industry standard for heating and cooling load calculations. BLAST output may be utilized in conjunction with the LCCID (Life Cycle Cost in Design) program to perform an economic analysis of the building/system/plant
  - http://www.bso.uiuc.edu/

Energy Simulation Software

- **DOE - 2**
  - Department of Energy Lawrence Berkley Labs
  - Hourly, whole-building energy analysis program calculating energy performance and life-cycle cost of operation. Can be used to analyze energy efficiency of given designs or efficiency of new technologies. Other uses include utility demand-side management and rebate programs, development and implementation of energy efficiency standards and compliance certification, and training new corps of energy-efficiency conscious building professionals in architecture and engineering schools.
  - http://simulationresearch.lbl.gov

Energy Simulation Software

- EnergyPlus
  - Department of Energy Lawrence Berkley Labs & UIUC/CERL
  - New generation building energy simulation program designed for modeling buildings with associated heating, cooling, lighting, ventilating, and other energy flows.
  - Builds on the most popular features and capabilities of BLAST and DOE-2 but includes many innovative simulation capabilities including time steps of less than an hour and modular systems simulation modules that are integrated with a heat balance-based zone simulation. Other planned simulation capabilities include solar thermal, multizone air flow, and electric power simulation including photovoltaic systems and fuel cells.
  - Highlights of using EnergyPlus version 1.0 include
    - Extensive example HVAC input files
    - Heat pump simulations
    - Weather processor

Energy Simulation Software

- **FEDS** (Facility Energy Decision System)
  - DOE Pacific Northwest National Laboratory
  - Provides a comprehensive method for quickly and objectively identifying energy improvements that offer maximum savings. FEDS makes assessments and analyzes energy efficiency of single buildings, multiple buildings, or all buildings of an entire facility. It provides an easy-to-use tool for identifying energy efficiency measures, selecting minimum life-cycle costs, determining payback, and enabling users to prioritize retrofit options.

Energy Simulation Software

Mechanical Engineering Focus

- **TRACE** (Trane Air Conditioning Economics)
  - Trane Company
  - Lets you model virtually any building, air handling system, heating or cooling equipment, and economic/utility scenario then helps you quickly compare them. TRACE lets you model virtually any building, air handling system, heating or cooling equipment, and economic/utility scenario - then helps you quickly compare them. The program takes you step by step from basic building parameters, such as geographic location (TRACE 600 includes over 480 global weather profiles), to powerful system modeling, such as ice storage systems. Streamline data entry using extensive pre-built libraries and “master cards.”
  - http://www.trane.com/commercial/software

Energy Simulation Software

- **EZ DOE**
  - Lawrence Berkeley Laboratory
  - An easy to use version of DOE-2.
  - EZDOE calculates the hourly energy use of a building and its life-cycle cost of operation given information on the building's location, construction, operation, and heating and air conditioning system. Using hourly weather data and algorithms, EZDOE takes into account complex thermal storage effects of various building materials. In addition, it can also accurately simulate the operation of all types of heating and cooling plants including ice water thermal storage and cogeneration systems.
  - http://www.elitesoft.com
- **Energy Scheming**
  - University of Oregon
  - A design tool to help the user create an energy-efficient building; provides loads analysis for 24 hours for each of 4 seasonal evaluation days. Input is graphical and intuitive and is designed to support the earliest phases of design, where energy considerations can have the most impact.

Energy Simulation Software

- SUNREL
  - SUNREL is a detailed hourly building energy simulation program that aids in the design of small energy efficient-buildings where the loads are dominated by the dynamic interaction between the building's envelope, its environment, and its occupants.
  - http://www.nrel.gov/buildings/highperformance/software/sunrel.htm

- Energy 10
  - ENERGY-10, a PC-based design tool, helps architects and building designers quickly identify the most cost-effective, energy-saving measures for small commercial and residential buildings.
  - http://www.nrel.gov/buildings/energy10/

Energy Simulation Software

- RADIANCE
  - RADIANCE is UNIX freeware for lighting design and rendering, developed by the U.S. Department of Energy and the Swiss federal government, copyrighted by the Regents of the University of California.
  - http://radsite.lbl.gov/radiance/HOME.html
- The Home Energy Saver
  - The Home Energy Saver is designed to help consumers identify the best ways to save energy in their homes, and find the resources to make the savings happen. The Home Energy Saver was the first Internet-based tool for calculating energy use in residential buildings. The project is sponsored by the EPA and the DOE as part of the national ENERGY STAR Program for improving energy efficiency in homes.
  - http://hes.lbl.gov/HES/

Economics

- **DISCOUNT**
  - DOE
  - Program computes discount factors and related present values, future values, and periodic payment values of cash flows occurring at specific points.
  - Useful for solving life-cycle cost analysis problems that do not require the comprehensive summation and reporting capabilities provided by the BLCC program.
  - Performs all of the functions of standard discounting tables, computing present values of future amounts, future values of present amounts, present and future values of periodic payments, periodic payments corresponding to discount factors.
  - http://www.eren.doe.gov/femp/

Summary

- There are many more tools available for sustainable building and landuse analysis.
- Some general starting points for sustainable design tools
  - http://www.sustainable.doe.gov/toolkit
  - http://www.eren.doe.gov/buildings/tools_directory/
  - http://www.ebuild.com/
  - http://eetd.lbl.gov/ea/buildings.html
  - http://www.oikos.com/
  - http://www.rmi.org/index.html
  - http://www.ciwmb.ca.gov/RCP/